

TRANSLATION:

(19) Japanese Patent Office (JP) (11) Kokai No.: 9[1997]-268,034  
(12) Kokai Patent Gazette (A) (43) Kokai Date: October 14, 1997

EARLY DISCLOSURE  
[Unexamined Patent Application]

(51) Intl. Cl. <sup>6</sup> :	Ident. Code:	Office Ref.:	FI	Technology Display Location
C 03 C 25/02			C 03 C 25/02	N
D 03 D 15/00			D 03 D 15/00	E
		15/12		15/12
D 06 M 15/55			D 06 M 15/55	A
		15/568		15/568

No Examination Requested No. of Claims: 3 (total: 7 pages)

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(21) Application No.: 8[1996]-80,042  
(22) Application Date: April 2, 1996  
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APR 7 1998

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(54) [Title of the Invention]

### GLASS FIBER YARN WITH AN ATTACHED BINDER

(57) [Abstract]

[Problem] To provide binders for glass fiber which in turn can be made into twist-free glass fiber yarn with less fuzz and good traveling properties at low cost and without the need for a yarn twisting process.

[Solving Approach] Binder for glass fiber, characterized in that it contains a modified water-soluble epoxy product and/or a water-soluble urethane compound.

[Scope of the Patent Claim(s)]

[Claim 1] Binder for glass fiber, characterized in that it contains a modified water-soluble epoxy product and/or a water-soluble urethane compound.

[Claim 2] Glass fiber yarn, characterized in that the binder for glass fiber as described in Claim 1 is attached.

[Claim 3] Glass cloth, characterized in that it is woven from glass fiber yarn as described in Claim 2.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention] The present invention pertains to a binder for glass fiber and glass fiber yarn with this binder attached, and, moreover, to glass cloth woven from this binder-attached glass fiber yarn.

[0002]

[Conventional Techniques] Ordinarily, glass fiber yarn is produced by

rewinding spun yarn by a twiner and then drying the yarn. In this way, the yarn is twisted, and sometimes fuzz is produced or the yarn becomes stained because of the twining process, both of which raise the production cost. To seek out ways of dealing with these problems, studies were conducted on the direct use of the spun yarn cake, dried in a drying oven, as a starting material for glass cloth, but a conventional yarn cake with its double tapered ends, is thin with respect to its large inner diameter and, more importantly, it is difficult to handle because both ends are sharply pointed. The handling problems that are encountered include unstable traveling properties and the formation of fuzz when used as the weft. It has also been very difficult to package for transportation, and even when a package could be made up, the package itself would be unrealistically large for the weight to be transported.

[0003] In response to these problems, Japanese Kokai No. 5[1993]-254,877 discloses a method for winding the yarn in the form of a square-ended package of cheese. The quality was good even for glass fiber with monofilament diameters of  $3\text{-}9 \mu$ , which is what is generally used for yarn. These accomplishments were realized by providing a tension relaxing device in the spinning process and thus reducing the tension of the yarn. The use of this method produces an easily manageable form and the volume of the product can be made small, which enables realistic packaging for transportation.

[0004]

[Problems to be Solved by the Invention] Conventional binders are designed on the premise that they will be dried as the yarn is swung through the air by a traveler during the twining process. Accordingly, when a package of yarn with a conventional starch-based binder attached to it, as disclosed in

Japanese Kokoku No. 3[1991]-35,639 or in Japanese Kokai No. 3[1991]-183,644 is dried in a drying oven, problems develop in that both ends harden and fuzz forms, or in that the yarn gets caught at the end when used as the weft, so no weaving can be done on an air jet loom. Similar problems were also encountered with conventional resin-based binders for which no binder-removal process is required (hereinafter referred to as oil removal), as can be seen in Japanese Kokoku No. 52[1977]-6,393, Japanese Kokoku No. 62[1987]-12,184, Japanese Kokoku No. 62[1987]-50,427, and Japanese Kokai No. 4[1992]-228,459.

[0005]

[An Approach to Solving the Problems] The present inventors carried out extensive research to try and solve the problems encountered with conventional binders, as described above, and found that if a binder that contains either a modified water-soluble epoxy product, a water-soluble urethane compound, or both of these as film-forming agents is used, twist-free glass fiber yarn with less fuzzing and good traveling properties can be produced at low cost without the need of a twining process.

[0006] It was also found that glass cloth woven from this twist-free glass fiber yarn allows oil removal by heating, as is done conventionally, because the binder used incorporates film-forming agents with good combustibility. Said glass cloth also allows oil removal by washing with water because the film-forming agents used are water-soluble. Moreover, the oil-removal process can be omitted because the binder used has good affinity for resins. What is more, said glass cloth can be easily impregnated with resins because the yarn is twist-free and therefore the tow is more open than with twisted yarn.

[0007] It was as a result of these discoveries that the present inven-

tion was developed. A characterizing feature of the present invention is a glass fiber binder that contains a modified water-soluble epoxy product and/or a water-soluble urethane compound.

[0008] Another characterizing feature of the present invention is glass fiber yarn to which the above-mentioned glass fiber binder is attached.

[0009] A further characterizing feature of the present invention is glass cloth that is woven from the above-mentioned binder-attached glass fiber yarn.

[0010]

**[Embodiments of the Invention]** An essential requirement of the glass fiber binder of the present invention is that it must contain a modified water-soluble epoxy product and/or a water-soluble urethane compound.

[0011] The modified water-soluble epoxy product is a modified product obtained by the addition reaction of a polyhydric alcohol and an epoxy resin. Epoxy resins which can be favorably used for this modification process include those derived from bisphenol A, but these are not the only choices.

[0012] Polyhydric alcohols which can be favorably used include poly-alkylene glycols such as polyethylene glycol, polyoxyethyleneoxypropylene glycol, polypropylene glycol, polytetramethylene glycol, and poly(1,2-butylene glycol), but these are not the only choices. The molecular weight of the polyhydric alcohol is preferably 600-10,000. If the molecular weight of the polyhydric alcohol is less than 600, the binder lacks lubrication properties and fuzz forms more easily, and if the molecular weight is more than 10,000, the viscosity increases, and the binder becomes difficult to use.

[0013] The proportion of epoxy resin and polyhydric alcohol is preferably less than 30 wt.% for the former and 70 wt.% for the latter. If the

epoxy resin is 30 wt.% or more and the polyhydric alcohol is less than 70 wt.%, a great deal of fuzz forms during weaving. What is more, the tautness of the epoxy resin intensifies and process operability tends to deteriorate.

[0014] The proportion of the epoxy resin and polyhydric alcohol is more preferably 20-2 wt.% for the former and 80-98 wt.% for the latter. If the polyhydric alcohol exceeds 98 wt.%, it becomes difficult to obtain a suitable bundling ability.

[0015] The modified epoxy product obtained from the epoxy resin and polyhydric alcohol is water soluble and has a preferred molecular weight of 1,000-100,000. When the molecular weight is less than 1,000, size migration occurs, and the traveling properties of the yarn during the weaving process become unstable and/or fuzz is produced. When the molecular weight is more than 100,000, the viscosity increases to a point where the binder cannot be used.

[0016] On the other hand, the water-soluble urethane compound which is used in place of the modified epoxy product or together with the modified epoxy product in the binder of the present invention, is a compound that can be obtained by reacting a polyisocyanate with a polyhydric alcohol.

[0017] Examples of polyisocyanates that can be used for the production of these urethane compounds include hexamethylene diisocyanate, tolylene diisocyanate, diphenylmethane diisocyanate, ethylene diisocyanate, and tetraalkyldiphenylmethane diisocyanates, but any compounds with two or more isocyanate groups can be used.

[0018] Polyhydric alcohols that can be favorably used include polyalkylene glycols such as polyethylene glycol, polyoxyethyleneoxypropylene glycol, polypropylene glycol, polytetramethylene glycol, and poly(1,2-butylene

glycol), but these are not the only choices. The molecular weight of the polyhydric alcohol is preferably about 5,000-20,000. When the molecular weight is less than 5,000, the yarn hardens and causes fuzz problems when treated with the binder according to the present invention, and when the molecular weight is more than 20,000, the viscosity increases to a point that the binder can no longer be used.

[0019] The proportion of polyisocyanate and polyhydric alcohol is preferably less than 30 wt.% for the former and 70 wt.% or more for the latter. If the proportion of polyisocyanate is 30 wt.% or more and the proportion of polyhydric alcohol is less than 70 wt.%, large quantities of fuzz forms during weaving, and process operability tends to deteriorate.

[0020] The proportion of polyisocyanate and polyhydric alcohol is more preferably 30-2 wt.% for the former and 70-98 wt.% for the latter. If the amount of polyhydric alcohol exceeds 98 wt.%, the desired bundling ability becomes difficult to achieve.

[0021] The modified urethane product obtained by reacting a polyisocyanate with a polyhydric alcohol is water soluble and its molecular weight is preferably 20,000-400,000. When the molecular weight is less than 20,000, the film-forming ability declines, and the "fuzz laydown" effect becomes insufficient, and when the molecular weight is more than 400,000, the viscosity becomes so high that operability deteriorates.

[0022] The proportion of the above-mentioned modified water-soluble epoxy product and/or water-soluble urethane compound in the binder is preferably 0.2-8.0 wt.%, and more preferably 0.3-5.0 wt.%. Furthermore, the coating ratio of the binder to glass fiber is preferably 0.05-2.00 wt.%, and more preferably 0.10-1.00 wt.%.

[0023] When necessary, an ingredient that provides the yarn with lubricity, such as a nonionic lubricant or cationic lubricant, a coupling agent for the glass fiber, such as a chromium-based coupling agent or titanium-based coupling agent, or an antistatic agent such as ammonium chloride, ammonium sulfate, or lithium chloride, can be incorporated in the binder of the present invention. Moreover, other film-forming agents such as polyurethane emulsions, epoxy emulsions, polyethylene emulsions, polyvinyl acetate emulsions, polyethylene glycol, and acrylic emulsions can also be used.

[0024] Thus far, only the binder of the present invention has been described, but the present invention is also characterized by twist-free glass fiber yarn to which this binder is attached. Said glass fiber to which the binder is attached is fiber with a diameter of from 3 to several tens of microns and count numbers of 900-37, examples including conventional E glass or T glass, D glass, and C glass. The coating can be achieved by methods such as dipping, a roller or belt applicator, or spraying.

[0025] Furthermore the present invention pertains to glass cloth characterized in that it is generated by weaving the above-mentioned binder-attached twist-free glass fiber yarn. The weaving can be achieved by using an air jet loom, a water jet loom, a Repia [phonetic spelling; unverified -- Tr. Ed.] loom, a shuttle loom, etc.

[0026]

[Effect of the Invention] By the use of the present invention, a binder can be produced which limits the amount of fuzz and provides good traveling properties even for a square-ended package (like that of cheese) which has been wound by the spinning method described in Japanese Kokai No. 5[1993]-254,877 and then dried in a drying oven; and which can be used in any of the

oil-removal methods, such as by heating or by washing with water, and also when there is no oil removal, by incorporating a modified water-soluble epoxy product and/or a water-soluble urethane compound as film-forming agents. The modified epoxy product and urethane compound contain polyhydric alcohols such as polyethylene glycol or polyoxyethyleneoxypropylene glycol as essential components, so that a soft film forms even if the yarn has to be dried at 100-130°C in a drying oven, and the yarn does not become too hard and less fuzz is produced. With regard to traveling properties, the yarn produced according to the present invention no longer gets caught at the end, because the yarn separates well in spite of the moderate bond strength of the film-forming agent. Furthermore, because film-forming agents with good combustibility and water solubility are used, the size can be removed either by the oil removal process by heating or by the oil removal process by washing with water. Moreover, because film-forming agents with good affinity for resins are used, methods that do not include oil removal can also be used. And glass cloth woven from glass fiber yarn to which the invention binder is attached can be easily impregnated with resins, because the yarn is twist-free and thus the tow is more open than in twisted yarn.

[0027]

**[ACTUAL EXAMPLES]**

The present invention will now be described below with reference to actual examples. "%" represents "weight%" unless otherwise indicated.

[0028]

**[Actual Example 1]**

A binder was prepared which contained 1.50 wt.% of a modified water-soluble epoxy product composed of 90 wt.% polyethylene glycol and 10 wt.% bis-

phenol epoxy resin, 0.80 wt.% of paraffin emulsion, 0.08 wt.% of an acetic acid-activated product of a condensation product of tetraethylenepentamine and stearic acid, 0.35 wt.% of  $\gamma$ -glycidoxypolypropyltrimethoxysilane (trade name A-187 and produced by the Nippon Unicar Co., Ltd.), 0.03 wt.% of acetic acid, and 0.90 wt.% of a polyethylene emulsion (trade name Hightech E4B and produced by the Toho Chemical Co., Ltd.), with the balance consisting of water. Glass fiber of ECD450 was dipped in this binder and thus coated with 0.25% of the binder. Next, a spun, double-square-ended package yarn was dried at 120°C, prepared for weaving through a high-speed warper, coated with 0.30% of a non-ylphenyl ether-type surfactant (trade name Emulgen 985 and produced by the Kao Soap Co., Ltd.) by a pasting machine, and plain woven in an arrangement consisting of 60 warps/25 mm and 46 wefts/25 mm on a high-speed air jet loom to obtain glass cloth. The fuzz of the glass cloth obtained and the traveling properties of the yarn during weaving are shown in Table 1.

[0029] This glass cloth was then washed to a coating ratio of 0.15% by spraying water uniformly at a spray pressure of 50 kg/cm<sup>2</sup> with the use of a high-pressure water sprayer, then it was dipped in a treatment solution containing 1.00% of *N*- $\beta$ -(*N*-vinylbenzylaminoethyl)- $\gamma$ -aminopropyltrimethoxysilane hydrochloride (trade name SZ6032 and produced by the Toray Silicon Co., Ltd.) and the acetic acid needed to dissolve it, squeezed with a mangle, and dried to obtain a glass cloth with a coating ratio of 0.25%. The resin impregnability of this glass cloth and the water absorbance and welding heat resistance of laminates made from it are given in Table 2.

[0030] The following evaluation methods were used.

[0031]

(1) Coating Ratio

At least 1 g of a test specimen was sampled and dried at  $110 \pm 5^\circ\text{C}$  for at least 1 hour, cooled to room temperature in a desiccator, and its weight ( $M_1$ ) was recorded. The resulting sample was heated to constant weight in a muffle furnace kept at  $625 \pm 20^\circ\text{C}$ , then placed in a desiccator and left to cool to room temperature. Its weight ( $M_2$ ) was then recorded and the coating ratio was calculated by the following equation:  $C = (M_1 - M_2)/M_1 \times 100$ , where  $C$  is the coating ratio of the test specimen (weight%).

[0032]

(2) Fuzz

Cloth was woven on a loom, then the fuzz on the cloth surface was counted and the cloth was graded according to evaluation criteria divided into 8 ranks. Rank 1 indicates the lowest fuzz count and rank 8 indicates the highest fuzz count, with ranks up to 2-3 suited for normal use.

[0033]

(3) Traveling Properties

The yarn was shot as weft on an air jet loom and the arrival time was measured by an evaluating machine. This value and the weavability of the yarn based on the number of stoppages of the loom were considered together for evaluation purposes. The evaluation criteria were divided into 8 ranks, the smaller numbers indicating better results.

[0034]

(4) Resin Impregnability

The viscosity of type FR-4 epoxy resin varnish according to JIS standards was adjusted to 150 cps with a solvent, a  $10 \text{ cm} \times 10 \text{ cm}$  piece of glass cloth was floated gently on the varnish, and the time it took for the bubbles in the strand to disappear completely was recorded.

[0035]

(5) Water Absorbance of a Laminate

Surface-treated glass cloth was impregnated with type FR-4 epoxy resin varnish according to JIS standards, and dried at 130°C for 8 minutes to obtain a prepreg. Four sheets of this prepreg were stacked in this Actual Example 1, and also in Actual Examples 2, 3, and 4, and in Comparison Example 1 given later, and 8 sheets were stacked in Actual Examples 5 and 6, and in Comparison Example 2 given later. A piece of copper foil was placed on the top and bottom and the resulting stack was molded by heating at 180°C for 90 minutes at a reduced pressure of 720 mm Hg and under a load of 20 kg/cm<sup>2</sup>. The copper foil was then removed by etching to obtain a test specimen. This laminated test specimen was boiled in a pressurized autoclave at 133°C for 120 minutes, then the water absorbance was measured.

[0036]

(6) Welding Heat Resistance of a Laminate

A laminated test specimen obtained by a method almost the same as in section (5) above was boiled in a pressure cooker at 133°C for 120 minutes, 240 minutes, 360 minutes (or 90 minutes, 120 minutes, 150 minutes), then dipped in a 260°C welding bath for 20 seconds, removed, and the test specimen was then examined for bulging or peeling. The welding heat resistance was evaluated by grading the appearance of the test specimen with O, Δ, or X, where "O" indicates no bulging, "Δ" indicates one small bulge, and "X" indicates two or more bulges.

[0037]

[Actual Example 2]

A binder was prepared which contained 2.00 wt.% of a modified water-

soluble epoxy product composed of 92 wt.% polyethylene glycol and 8 wt.% bis-phenol epoxy resin, 1.00 wt.% of butyl stearate emulsion, 0.10 wt.% of an acetic acid-activated product of a condensation product of tetraethylenepenta-mine and stearic acid, 0.60 wt.% of *N*- $\beta$ -(*N*-vinylbenzylaminoethyl)- $\gamma$ -amino-propyltrimethoxysilane hydrochloride (trade name SZ6032 and produced by the Toray Silicon Co., Ltd.), and 0.30 wt.% of acetic acid, with the balance consisting of water. Glass fiber of ECD450 was dipped in this binder and thus coated with 0.20% of the binder. Next, a spun, double-square-ended package yarn was dried at 120°C, prepared for weaving through a high-speed warper, coated with 0.30% of a nonylphenyl ether-type surfactant (trade name Emulgen 985 and produced by the Kao Soap Co., Ltd.) by a pasting machine, and plain woven in an arrangement consisting of 60 warps/25 mm and 46 wefts/25 mm on a high-speed air jet loom to obtain glass cloth. The fuzz of the glass cloth obtained and the traveling properties of the yarn during weaving are shown in Table 1.

[0038] This glass cloth was then washed to a coating ratio of 0.15% by spraying water uniformly at a spray pressure of 50 kg/cm<sup>2</sup> with the use of a high-pressure water sprayer, then it was dipped in a treatment solution containing 1.00% of *N*- $\beta$ -(*N*-vinylbenzylaminoethyl)- $\gamma$ -aminopropyltrimethoxysilane hydrochloride (trade name SZ6032 and produced by the Toray Silicon Co., Ltd.) and the acetic acid needed to dissolve it, squeezed with a mangle, and dried to obtain a glass cloth with a coating ratio of 0.25%. The resin impregnability of this glass cloth and the water absorbance and welding heat resistance of laminates made from it are given in Table 2.

[0039]

[Actual Example 3]

Glass cloth was produced in about the same way as in Actual Example 2, except that no oil removal by washing with water nor any silane coupling agent treatment were carried out. The resin impregnability of this glass cloth and the water absorbance and welding heat resistance of laminates made from it are given in Table 2.

[0040]

[Actual Example 4]

Glass cloth was produced in about the same way as in Actual Example 1, except that oil removal by washing with water was changed to oil removal by heating. The resin impregnability of this glass cloth and the water absorbance and welding heat resistance of laminates made from it are shown in Table 2.

[0041]

[Actual Example 5]

A binder was prepared which contained 1.00 wt.% of a modified water-soluble epoxy product composed of 90 wt.% polyethylene glycol and 10 wt.% bis-phenol epoxy resin, 0.80 wt.% of a water-soluble urethane compound composed of 88 wt.% polyoxyethyleneoxypropylene glycol and 12 wt.% diphenylmethane diisocyanate, 1.10 wt.% of butyl stearate emulsion, 0.09 wt.% of an acetic acid-activated product of a condensation product of tetraethylenepentamine, and stearic acid, 0.30 wt.% of  $\gamma$ -glycidoxypropyltrimethoxysilane (trade name A-187 and produced by the Nippon Unicar Co., Ltd.), and 0.03 wt.% of acetic acid, with the balance consisting of water. Glass fiber of ECG75 was dipped in this binder and thus coated with 0.27% of the binder. Next, a spun, double-square-ended package yarn was dried at 120°C, prepared for weaving through a high-speed warper, coated with 0.33% of a nonylphenyl ether-type surfactant

(trade name Emulgen 985 and produced by the Kao Soap Co., Ltd.) by a pasting machine, and plain woven in an arrangement consisting of 44 warps/25 mm and 32 wefts/25 mm on a high-speed air jet loom to obtain glass cloth. The fuzz of the glass cloth obtained and the traveling properties of the yarn during weaving are shown in Table 1.

[0042] This glass cloth was then washed to a coating ratio of 0.15% by spraying water uniformly at a spray pressure of 50 kg/cm<sup>2</sup> with the use of a high-pressure water sprayer, then it was dipped in a treatment solution containing 1.00% of *N*- $\beta$ -(*N*-vinylbenzylaminoethyl)- $\gamma$ -aminopropyltrimethoxysilane hydrochloride (trade name SZ6032 and produced by the Toray Silicon Co., Ltd.) and the acetic acid needed to dissolve it, squeezed with a mangle, and dried to obtain a glass cloth with a coating ratio of 0.25%. The resin impregnability of this glass cloth and the water absorbance and welding heat resistance of laminates made from it are given in Table 3.

[0043]

[Actual Example 6] Glass cloth was produced in about the same way as in Actual Example 6 [sic; -- Tr. Ed.], except that oil removal by washing with water was changed to oil removal by heating. The resin impregnability, water absorbance, and welding heat resistance are shown in Table 3.

[0044]

[Comparison Example 1] A comparison binder was prepared which contained 4.00 wt.% of hydroxypropylated high-amylose cornstarch (which is a conventional film-forming agent), 1.00 wt.% of hydroxypropylated normal cornstarch, 1.00 wt.% of an emulsion of hydrogenated vegetable oil, and 0.20 wt.% of an acetic acid-activated product of a condensation product of tetraethylenepentamine and stearic acid, with the balance consisting of hot water. Glass fiber

of ECD450 was dipped in the binder produced and thus coated with 0.90% of the binder. Next, a spun, double-tapered-end cake was rewound while applying 1z (1 twist/inch in the Z direction) of twist by a twiner, prepared for weaving through a high-speed warper, coated with a paste by a pasting machine, and plain woven in an arrangement that consisted of 60 warps/25 mm and 46 wefts/25 mm on a high-speed air jet loom to obtain glass cloth. The fuzz of the glass cloth obtained and the traveling properties of the yarn during weaving are shown in Table 1.

[0045] Next, this glass cloth was subjected to oil removal by heating, dipped in a treatment solution that contained 1.00% of *N*- $\beta$ -(*N*-vinylbenzyl-aminoethyl)- $\gamma$ -aminopropyltrimethoxysilane hydrochloride (trade name SZ6032 and produced by the Toray Silicon Co., Ltd.) and the acetic acid needed to dissolve it, squeezed with a mangle, and dried to obtain a glass cloth with a coating ratio of 0.10%. The resin impregnability of this glass cloth and the water absorbance and welding heat resistance of laminates made from it are given in Table 2.

[0046]

[Comparison Example 2] A binder was prepared which contained 3.00 wt.% of hydroxypropylated high-amylose cornstarch (which is a conventional film-forming agent), 3.00 wt.% of hydroxypropylated normal cornstarch, 0.90 wt.% of an emulsion of hydrogenated vegetable oil, and 0.30 wt.% of an acetic acid-activated product of a condensation product of tetraethylenepentamine and stearic acid, with the balance consisting of hot water. Glass fiber of ECG75 was dipped in the binder produced and thus coated with 0.85% of the binder. Next, a spun, double-tapered-end cake was rewound while applying 0.7z (0.7 twist/inch in the Z direction) of twist by a twiner, prepared for weaving

through a high-speed warper, coated with a paste by a pasting machine, and plain woven in an arrangement that consisted of 44 warps/25 mm and 32 wefts/25 mm on a high-speed air jet loom to obtain glass cloth. The fuzz of the glass cloth obtained and the traveling properties of the yarn during weaving are shown in Table 1.

[0047] Next, this glass cloth was subjected to oil removal by heating, dipped in a treatment solution containing 1.10% of *N*- $\beta$ -(*N*-vinylbenzylaminoethyl)- $\gamma$ -aminopropyltrimethoxysilane hydrochloride (trade name SZ6032 and produced by the Toray Silicon Co., Ltd.) and the acetic acid needed to dissolve it, squeezed with a mangle, and dried to obtain a glass cloth with a coating ratio of 0.12%. The resin impregnability of this glass cloth and the water absorbance and welding heat resistance of laminates made from it are given in Table 3.

[0048]

[Table 1]

TABLE 1. QUALITY OF THE GLASS CLOTH AND TRAVELING PROPERTIES OF THE YARN. KEY:  
 (a) Actual Example .... ; (b) Comparison Example .... ; (c) coating ratio, %; (d) fuzz; (e) traveling properties; and (f) (rank).

	付着率 (c) (%)	毛(粗) (等級)(f)	飛走性 (等級)(f)	(e)
(a) 実施例1	0.25	1	1	
(a) 実施例2	0.20	3	1	
(a) 実施例5	0.27	3	2	
(b) 比較例1	0.90	4	3	
(b) 比較例2	0.85	3	3	

[0049]

[Table 2]

TABLE 2. IMPREGNABILITY OF THE GLASS CLOTH AND LAMINATE PROPERTIES (Part 1).  
 KEY: (a) Actual Example .... ; (b) Comparison Example 1; (c) impregnability; (d) laminate properties; (e) water absorbance, %; (f) welding heat resistance; (g) .... minutes; and (h) .... seconds.

	(c) 含浸性	(d) ラミネート特性			
		(e) 吸水率 (%/g) PC120分	(f) 半田耐熱性		
			PC120分	PC240分	PC360分
(a)	実施例1 3分30秒 (g) (h)	1.30	○○○	○○○	○○○
(a)	実施例2 3分00秒 (g) (h)	1.32	○○○	○○○	○△△
(a)	実施例3 4分30秒 (g) (h)	1.45	○○○	○○△	△△△
(a)	実施例4 5分00秒 (g) (h)	1.33	○○○	○○○	△△△
(b)	比較例1 13分30秒 (g) (h)	1.51	○○○	○○△	△△×

[0050]

[Table 3]

TABLE 3. IMPREGNABILITY OF GLASS CLOTH AND LAMINATE PROPERTIES (Part 2). KEY:  
(a) Actual Example .... ; (b) Comparison Example 2; (c) impregnability; (d) laminate properties; (e) water absorbance, %; (f) welding heat resistance; (b) .... minutes; (h) .... seconds; and (i) 30 minutes or more.

	(c) 含浸性	(d) ラミネート特性			
		(e) 吸水率 (%) PC120分	(f) 半田耐熱性		
			PC90分	PC120分	PC150分
(a)	実施例5	8分30秒	(g) 0.74	(g) ○○○	(g) ○○○
(a)	実施例6	7分00秒	0.78	○○○	○○○
(b)	比較例2	30分以上	0.80	○○○	○○△

[0051] As is apparent from Tables 1-3, Actual Examples 1-6 are better than Comparison Examples 1-2 with regard to fuzz control, traveling properties, impregnability, and welding heat resistance.